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ABSTRACT

A computer-based education system, PLATO (Programed Logic for Autcmatic Teaching Operations), has been used to teach nursing students at Mercy Hospital School of Nursing in Urbana, Illinois since 1963. PLATO III, the model now being used in a maternity nursing course, has 70 student terminals (20 of which can be used at any one time) connected to a CDC 1604 computer. Approximately, 120 students have had lessons in maternity nursing via PLATO: 100 of these received the complete series of 22 lessons. The total time students required for completion of the series ranged from 28 to 40 hours. This compared with 84 hours spent in a classroom by control students. Student reaction to the computer varied considerably from one period of time to the next and from individual to individual. However, one-half of the students did rate PLATO as the preferred medium for learning (as compared with lecture, textbook, film, and television); whereas, only one student in 25 rated PLATO as the worst medium. The course was found to be suitable for student learning in an associate degree nursing program. When the course and PLATO equipment were transferred to the regular classroom the seven classroom instructors found them easy to use. It is desirable that teachers using computerized instruction change their role concept. (MF)

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USING A COMPUTER TO TEACH NURSING

by Maryann D. Bitzer, R.N., M.S.
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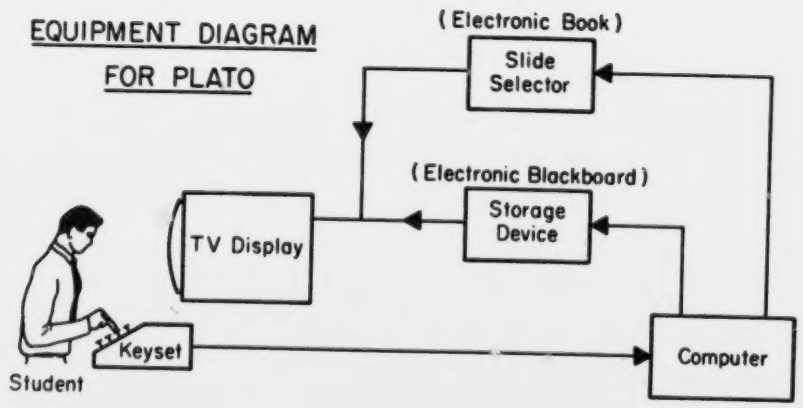
Figure 1



USING A COMPUTER TO TEACH NURSING

by Maryann D. Bitzer, R.N., M.S.
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THIS fall the students at Mercy Hospital School of Nursing in Urbana, Illinois, saw the following entry on their class schedule: Maternity Nursing — Computer Class. As in the past three years, the students enrolled in our maternity nursing course are receiving a major portion of their instruction via PLATO (Programmed Logic for Automatic Teaching Operations), a computer-based education system.[1]

Let us watch one of these students as she takes her place at the student console. Before her is a television screen and an electronic keyset similar to that of a standard typewriter. A message on the television screen says "Welcome to PLATO." The student types her name and thus begins a series of twenty-two lessons in which she will interact with the computer. On the TV screen the computer will present her with simulated patients, problem situations, questions, and will provide her with information in written or pictorial form. She will perform experiments, gather data, and answer the computer's questions by means of her computer-connected terminal. The computer will immediately process her answers and judge them in a variety of ways.

Figure 1 illustrates the channels of communication between the student and the computer. The students share the slide selector and the computer, but each student has her own keyset and TV screen. PLATO III, the model our students are now using, has seventy student terminals (twenty of which can be used at any one time) connected to a CDC 1604 computer.

The electronic book and the electronic blackboard are the sources from which the computer selects the information presented to the student. The electronic book consists of 122 slides which are prestored as 35 mm. images in a computer-controlled electronic slide selector. Each slide contains an illustration or textual information. For our type of lesson material, from one and one half to two hours of instruction requires, on the average, 80 slides. The student is presented with the slide she requests in one millionth of a second. Although this slide selector is shared by all students, the students can view the same or different slides simultaneously.

The electronic blackboard consists of a storage tube for each student station. These tubes are also under computer control,

and diagrams, symbols, or words are plotted on them, point-by-point, for each student. Up to 700 alphanumeric characters can be written each second, and the entire blackboard can be erased in one fifth of a second.

A unique feature of this system is the super-imposition of images from the blackboard and electronic slide selector on the students' TV display. This feature enables a student to fill in blanks on a slide, to obtain graphical plotting superimposed on pictures, et cetera. Other devices such as films, physiological recording devices, and experimental apparatus may also be placed under computer control.

Our work in computer-based education for nursing began in 1963 when, using PLATO as a simulated laboratory, we structured a learning situation that was almost completely student-directed.[2] During the few lessons in this project the student was forced to become an active participant in the learning process, instead of taking the passive role one assumes when listening to a lecture. In the lesson "Care of the patient with a myocardial infarction," she controlled both the rate and the direction of her learning. According to our findings, the students in the experimental group did as well or better than those in the control group, and the more active a student had been in the learning process, the more she had learned. Moreover, one student, who had a record of poor classroom performance, became a high achiever in the computer lessons. A profile of her step-by-step progress through the lesson material indicated that her method of approach varied from that of the majority of the students in the class. It seemed that she could learn if allowed to approach the material in a manner which she found best for her. This finding pointed to another advantage of computer-based education. Many learners probably never reach their potential level of achievement because our usual teaching

system does not allow them to discover or use their optimal learning approach.

The present project,[3] in which we adapted a maternity nursing course for use on PLATO, was begun in 1966. Although for the purposes of this study we intentionally did not integrate the twenty-two computerized lessons into an instructor taught course, we believe that computer-based education should not be a complete substitute for the classroom instructor, but rather that it should be used to do what it can do for nursing education.

What it might do, we thought, was assist in meeting some of the challenges which confront us in nursing education today. With technology advancing so rapidly, we believed that the most important of these challenges is to stress flexibility, creativeness, and a problem-solving approach in our educational program so that it will produce nurses of the type we need today. Therefore in preparing the material we strove to:

1. Provide flexibility, allowing the student maximum control

"Computer-based education is intended to supplement rather than supplant the teacher."

over the direction and rate of her learning. This goal was based on the belief that some material has no obvious "best" sequence and that students may use different learning strategies in the same learning situation.

2. Further encourage open-mindedness of approach by allowing the student to construct natural language responses to questions and by providing the "keyword" judger with various acceptable alternative answers.
3. Help the student to develop or reinforce critical thinking skills by the method of presentation or teaching logic (rules).

For the achievement of the last objective, the student is presented with commonly encountered questions or problems, and the teaching rules are arranged so that she must think about what information she needs, think of and investigate possible solutions or sources of information, interpret and sort the data provided, select her solution (response), and test (judge) it. The information needed to answer the questions or solve the problems is prestored in, or calculated by, the computer and is provided to the student in response to her inquiries. The computer provides appropriate feedback to the student's constructed response, thereby reinforcing a correct approach (answer) or, in the case of an incorrect response, encouraging (forcing) the student to a new approach while providing her with specific assistance for particular error habits.

The approach used varies somewhat according to the type of lesson material being presented. In general, we used a combination of what we term "tutorial" and "inquiry" approaches that involve instructional branching contingent upon student responses and emphasize student-directed inquiry in data collection and student-system interaction.

The twenty-two lessons were divided according to content

rather than time. Behavioral objectives were developed for each lesson. To complete the course, the student must answer every question in every lesson correctly.

The material is presented in the manner deemed best suited to the particular content. The lessons range in complexity from a simple identification exercise in a review of anatomy to complicated investigation procedures such as are found in a physiology lesson in which the computer generates and graphically plots the development, maturation, and fertilization of an ovum in addition to generating and supplying other pertinent information in accordance with the specifications in the student's request. After collecting the data day by day, the student is asked to analyze the information and form certain conclusions from her deductions.

Again looking over the shoulder of our student, we see that her keyset has, in addition to the alphanumeric characters which she uses to respond to questions, special keys which are used to control her progress through the lesson. The function of the control keys utilized in the maternity nursing course can be seen in the simplified flow diagram of the teaching logic (teaching rules) in *Figure 2*.

The large block labeled Main Sequence is the minimum amount of material that must be used by the students and consists of instructions, text, and questions. If there are no questions to be answered on a slide, the student may continue to the next page in the lesson by pressing the CONT (Continue) button, but if there is a question on the page, she must answer it correctly before she proceeds to the next page. If more than one question is presented on a page, she must answer all of the questions correctly before proceeding, but she may answer them in any order she wishes. She may return to preceding pages by pressing the REV (Reverse) button.

After typing her response, the student, by pressing the JUDGE key, asks the computer to evaluate her answer. If she has responded "slow heart beat" and it is the correct answer, she receives an OK and may continue to the next question or the next page. However, if her response is merely "heart," the computer prints NC (Not Complete), and if she spells heart "hart," the computer prints SP (Spelling). If her response is "fast heart beet," the computer says NO and x-es out "fast" and underlines "beet" as a misspelled word, so that she knows which part of the answer is incorrect. Incorrect responses are erased by pressing the ERASE key. The student is allowed as many attempts to answer a question as she wishes.

Several types of branching from the main sequence may take place. Because our material is presented in such a manner that the student must gather the information she needs, we have provided, under the heading Investigate Sequence, a variety of ways in which she may collect information. She may ask questions of the computer, do simulated experiments, and determine the results of treatments and tests performed under conditions which she specifies. By pressing the INV (Investigate) button, she is presented with some general categories of information which are available in the lesson — for example: "You may investigate Mrs. Dodd, or Baby Dodd." After selecting the area of general information she wishes, she is given a subcategory from which she makes a more detailed specification — for example: "Do you wish to observe the condition of Baby Dodd or investigate the effect of nursing strategies on his condition?" When the student has found the information she needs, she returns to the main sequence by pressing the AHA button.

There are also special buttons such as PLOT, with which the student requests the computer to do graphical plotting on her screen. In one such lesson the computer draws arrows that trace

the flow of blood through the fetal circulatory system.

If a student has difficulty, she may press the HELP key and be given a subproblem, a hint, or the answer, depending on which computer response the instructor has provided. A special type of help, such as clinical norms, may be provided when the student presses the DATA key. If she is not familiar with a term, she may press the DICT button, check the dictionary list, and type the word she wants defined. After using each of these keys the student returns to her place in the lesson by pressing the AHA key.

The Challenge Sequence allows supplementary material to be added as enrichment for faster students; if a student wants to try a challenge question, she presses the CH (Challenge) button and is provided with a more complex problem.

At any time in the lesson, the student may press a COMNT (Comment) button and type in her comments; thus, she has a means of expressing her feelings. The comments are valuable to the instructor, who uses student suggestions to improve her material. An "author mode" allows the instructor to modify or update material. This authoring, or manipulation of parameters, is done "on-line" at a student terminal while the students are working.

The computer makes and retains a complete recording of the student's responses, including a record of each key pressed and the time it was pressed. This information is available in two forms: a printed history of events that the instructor can read, and a record that is stored on magnetic tape. The latter can be processed by the computer for detailed statistical analysis or for investigating specific areas of concern, such as comments and incorrect responses.

Let us return to the student as she proceeds through the lesson, making use of the features just described. Her present

lesson is concerned with the antepartum care of Mrs. Dodd, the hypothetical patient whom the student cares for throughout a normal pregnancy, labor, and delivery. Mrs. Dodd suffers from many of the common discomforts of pregnancy.

To give the student a basis for understanding the cause of these discomforts, the lessons allow her to investigate the anatomic and physiologic changes which occur during pregnancy and give rise to symptoms. After determining the cause of the symptoms, the student is presented with an opportunity to theorize and test various nursing strategies to see which would relieve them. The question confronting her at this moment states that some pregnant women seem to be especially prone to varicosities of the lower extremities and asks why this is so (*Figure 3*). The student presses the Investigate button and sees a slide which asks her whether she wishes to investigate anatomic or physiologic changes, nursing strategies, or prenatal records. She specifies anatomic and physiologic changes and on the next slide specifies the circulatory system during the third trimester. She must then decide what information given to her by the computer is pertinent. Using the Dictionary button, she requests the computer to supply her with a definition of the word vasodilation, then returns to the question slide by pressing the AHA button. She types in her answer and asks the computer to judge it. The computer writes OK after her answer, and she proceeds to the next slide by pressing the Continue button.

Now she is presented with a slide that tells her that Mrs. Dodd is a secretary and remains employed during the third trimester. It asks her to list several suggestions she might make to Mrs. Dodd about how to prevent varicosities. The student presses the Investigate button again, and this time designates the Nursing Strategies category. On the subsequent slide she specifies the symptom as varicosities and the area of nursing strategy

as activities. The computer responds with a list of such activities as lie flat, elevate feet, and walk around hourly. The student selects any of these, and the computer responds with its effect upon the patient such as "may help" or "will aggravate."

After finding some nursing strategies which may help, the student returns to the question and types in her answer, using the erase button to erase a misspelled word. She enters the same answer twice, using different wording. Both of the answers are judged as OK, but as she attempts to continue to the next page, the computer states "duplicate answer." After changing one of the answers, she is allowed to proceed. *Figure 4* illustrates the various ways a student's answers may be judged.

Results

To date, approximately 120 of our students have had lessons in maternity nursing via PLATO; 100 of them received the complete series of twenty-two lessons. One class of students was divided into two groups matched according to ability. One group had the maternity nursing course on PLATO, and the other group, serving as a control, was given the course in the conventional classroom manner. The two groups had one common class per week — a two-hour clinical conference. Post-test scores indicated a significant gain by all students, and a comparison of final examination grades of the control and experimental groups did not indicate a significant difference. The total time that the PLATO students required to complete the lessons ranged from 28 to 40 hours. These students were allowed to review any lessons they wished, and if this review time and film time are included, the maximum time spent by a PLATO student was 50 hours as compared with the 84 hours each of the control students spent in the classroom. In other

words, the PLATO students learned the same amount of material in from one-third to one-half the time required in the classroom.

This time-saving feature of our computerized course has been demonstrated repeatedly. TABLE I illustrates the differences in the average time spent on twelve lessons by an earlier group of students who received the lessons on PLATO, as compared with

TABLE I.

COMPARISON OF INSTRUCTIONAL TIME FOR PLATO STUDENTS AND CLASSROOM STUDENTS

Lesson	*Instructional Hours*		*Percentage of PLATO Group Time to Classroom Group Time*
	PLATO Group	*Classroom Group*	
Anatomy Review	1.0	1.0	100%
Prenatal Care (1st trimester)	2.5	8.0	31
Prenatal Care (2nd trimester)	2.0	7.0	29
Prenatal Care (3rd trimester)	1.0	7.0	14
Physiology	2.0	6.0	33
Diet	2.0	5.0	40
Fetal Circulation and Fetal Pharmacology	2.5	5.0	50
Fetal Development	2.5	7.5	33
3 Ps (Powers, Passage, Passenger)	1.5	4.5	33
Mechanisms of Labor	2.0	4.0	50
Normal Labor and Delivery	2.5	6.0	42
Complications of Pregnancy	2.0	5.5	36
TOTAL	**23.5**	**66.5**	**35%**

the time it took an instructor to present the same material in the classroom. The average time spent by students on the computer was about one-third of the time required for presenting the material in the conventional classroom. We are presently attempting to replicate, under more stringent conditions, preliminary studies which indicated that the PLATO group retained more material than the students in the control group retained.

Student Reactions

Student reactions have varied considerably. One general statement that can be made at this time is that the student's favorable responses to the computer method of presentation seem to increase with the amount of exposure to the system. This finding is illustrated by one student's comments. Her initial encounter, which was brief and pleasant, resulted in the comment, "I love you computer." Two days later she wrote, "You did a very good job yesterday. Why did you goof up today? You were very frustrating at times. In fact I almost punched all your keys at once. How does that grab you? I'm not so sure I like a machine teaching me. It's going to take me awhile but I'm not promising you anything. I may never get to like you. Take that and that. I hate you!" At the end of the second week she commented, "I enjoyed this lesson. I'm not sure if it was because it was easier or because I finally got the hang of using the investigate button and did not get as frustrated." Near the end of the course she typed, "I am very glad you dwelled upon the normal. It is more important for us to know the normal so that we may determine the abnormal. This lesson called for quite a lot of investigation, which is very good. When you have to look for the answer, you learn a lot more."

Some of the other student comments which indicate a period of adaptation are: "I think I am going to like this computer after all." "My concentration is increasing with each lesson." "I really feel I learned a great deal from this lesson, and the use of the keys is easy to understand now." "Much better now. Really am enjoying it." "Today's lesson was very interesting and I felt like I knew what I was doing." "I now find this an interesting and unique way to obtain this information. It is particularly good in that illustrations may be used much more effectively."

It should be noted that in this course the students were exposed to a learning situation that was new to them in terms of having not only to learn to operate equipment but also to work from questions and search for information. For many, it was difficult to break out of the old You-tell-me-I'll-memorize-and-repeat-to-you pattern. Two students who at the beginning of the course reacted with tears and hostility said at the end of it, "I would never have believed you if you'd told me I'd be saying this now, but I'm really beginning to like this way of learning."

Students tend to attribute human characteristics to the computer, often expecting human-like responses. Therefore, one common annoyance reported by students is the necessity for fairly precise answers (even with the wide range of acceptable alternate responses allowed with the keyword judger).

Although some students stated that they prefer the "old-fashioned lecture," indications are that they accept PLATO as a legitimate educational medium. One half of the students have rated PLATO as the preferred medium for learning (as compared with lecture, textbook, film, and television) whereas only one in twenty-five rated PLATO as the worst medium.

Although most of the students have required a certain

amount of time to learn to operate the equipment, nearly four-fifths of them indicated that their concentration on the lesson material was not hindered by the mechanical operation of the terminals. For the most part, students do not feel that typing ability is essential to learning on PLATO, though knowledge of a standard typewriter keyboard enables them to work more rapidly.

Applicability in Other Programs

Can a computer-based course such as this one be utilized by instructors and faculties other than those who wrote it? What is its potential for utilization in nursing programs at other levels? How readily can the course be integrated into the curriculum by the regular teaching staff? Would they reteach the material in class? Would they desire major revisions? Do the lesson divisions provide adequate flexibility for the instructors to arrange or order the content as they desire?

Maternal and child health consultants from associate and baccalaureate degree programs have evaluated the course for its potential utilization at these levels. They have stated that the material is sufficient with respect to depth, accuracy, and specificity to aid students to learn the theoretical material required for functioning effectively as maternity nurses. The course was found to be suitable for student learning in an associate degree nursing program and, with a few modifications, to serve as the foundation for a maternity nursing course at the senior college level. In fact, the instructors of an associate degree program have incorporated the computer lessons in their course, reordering the sequence of the lessons to meet their own needs.

The course has also been transferred into the regular classroom and taught by seven maternity nursing instructors who

had not participated in developing it and who, although familiar with the lessons in printed form, had not completed the series of lessons on the computer. They found this amount of preparation to be adequate. In the words of one instructor:

> I found the PLATO equipment surprisingly easy to run. It is a lot like driving a car: I know how to make it go and about some of the more common things that can go wrong with it. This is enough to meet my needs; I do not have to know about combustion, valve lifters, et cetera. I found I could make the computer go without having to know how the slides are made, how the machines are loaded, started, stopped, and so on. Such information may sometimes be helpful, but it is not essential to my main goals — getting the lesson material to appear on the TV screens. The rest is the job of the computer lab people.

The Future

At the present time, most schools do not have computer-based education systems with the capabilities of the one described in this article, and the materials prepared for one system often are not compatible with other systems. However, the near future will see many changes in this field. The PLATO IV system, which is expected to be operational by 1973, will utilize a third generation computer capable of handling 4,000 student terminals and will have an improved low-cost student terminal which can be used at home as well as in the classroom. Moreover, the materials prepared for use on one PLATO IV system will be compatible with other systems.

The lower cost of the PLATO IV terminal and the larger number of terminals that it can serve will reduce the cost per student contact hour considerably. The student console for PLATO III costs approximately $5,000. Assuming a maximum of 50 student stations, an annual use of 2,000 hours per station,

and a five-year period for amortizing the cost of equipment, the present total operational cost is between $1.90 and $2.90 per student contact hour. The cost of the PLATO IV student console is expected to be $1,500. Assuming a maximum of 4,000 student stations, an annual use of 2,000 hours per station, and a five-year amortization period, the total operational cost of a PLATO IV system will be between 31 and 68 cents per student contact hour. Since this estimate is based on an eight-hour day, these costs can be further reduced by scheduling classes on the system for a larger part of the day, or by using the unscheduled time for other computational applications.[4] Telephone connections on a campus will add approximately 1 cent per student contact hour, and transmission to as many as 1,000 student stations at distances of up to 150 miles will add approximately 2 cents per student contact hour.

Contributions to Nursing Education

As is the case with other teaching tools, computer-based education is intended to supplement rather than supplant the teacher. Our study indicated that its unique features make it an ideal instructional method for training in general cognitive skills. The computer can provide individualized instruction, immediate feedback, and remedial training, as well as complex internal branching which allows the method of presentation or the type of material to be altered on the basis of the student's past performance.

There are many other advantages to the use of a computer-based education system. It lends stability to situations in which there is a shortage or a rapid turnover of faculty. Larger numbers of students can be taught effectively, without a comparable increase in faculty. More important, the use of a computer to present instructional information makes more effective

use of both instructor and student time. The constant availability of material allows students to learn at their own pace. Those students who need less time to complete the material are free to do independent study, to devote more time to another course, or just to have free time. On the other hand, students can have additional instructional time without feeling that they are slowing down the class. The instructor is freed from routine lectures and thus allowed more time to increase the depth of the learning experiences in the clinical situation and in psychosocial aspects of nursing and leadership. She has more time to provide individual instruction, communicate with the student, answer questions, conduct discussions, organize and manage her educational experiences, and provide guidance and inspiration.

Despite these advantages, it is likely that before computer-based education is adopted and used effectively, many of us will have to change our role concept. Will those of us who have felt satisfied and secure in the role of "dispenser of information" be able to become moderators and coordinators and do the individualized teaching that most of us say we wish we had time for now?

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[A 16mm, 11-minute color film "Computers Teach Nurses" is available upon request to:

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